



9-29-00

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U.S. Express Mail Label No. EL531623888US

Docket No. 071815.0490

99SC036

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Los Angeles, CA 90067-3021



TO: Commissioner for Patents  
Box Patent Application  
Washington D.C. 20231

**UTILITY PATENT APPLICATION TRANSMITTAL UNDER 37 C.F.R. 1.53(b)**

Transmitted herewith for filing is the patent application of:

**INVENTOR(S): John Hong**

**TITLE: METHOD AND APPARATUS FOR MODIFYING ACOUSTIC WAVE  
CHARACTERISTICS**

In connection with this application, the following are enclosed:

**APPLICATION ELEMENTS:**

- ☒ Specification (including Abstract): 16 pages
  - ☒ Claims: 51
  - ☒ Informal Drawings: 6 Sheets
  - Power of Attorney By Assignee and Exclusion of Inventor Under Rule 37 C.F.R. § 3.71
  - ☒ Declaration Under 37 C.F.R. § 1.63
    - ☒ Unsigned
    - ☐ Executed (original or copy)
    - ☐ Copy from a prior application (37 CFR 1.63(d))
- (relates to continuation/divisional boxes completed) - NOTE: Box below

**ACCOMPANYING APPLICATION PARTS:**

- ☐ Assignment Papers (cover sheet & document(s))
- ☐ Revocation and Power of Attorney
- ☐ Information Disclosure Statement(IDS) with PTO-1449.
  - ☐ Copies of IDS Citations
- ☐ Preliminary Amendment
- ☒ Check No. 13515 in the amount of \$1560.00 for filing fee.
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- ☐ Small Entity Statement(s)
  - ☐ Statement filed in prior application, status still proper and desired.
- ☐ Certified Copy of Priority Document(s) with Claim of Priority (if foreign priority is claimed).

**CONTINUING APPLICATION**, check appropriate box and supply the requisite information:

- ☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application Serial No. ☐.
- ☐ Amend the specification by inserting before the first line the following sentence: --This application is a ☐ continuation, ☐ divisional or ☐ continuation-in-part of application Serial No. ☐, filed ☐--

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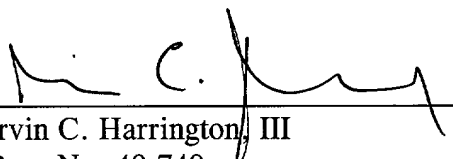
| (1)<br>For                            | (2)<br>Number Filed | (3)<br>Number Extra | (4)<br>Rate        | (5)<br>Basic Fee<br>\$690. (\$345.) |
|---------------------------------------|---------------------|---------------------|--------------------|-------------------------------------|
| Total Claims                          | 51 - 20 = 31        | 31                  | x \$18<br>(x \$9)  | 558.                                |
| Independent<br>Claims                 | 7 - 3 = 4           | 4                   | x \$78<br>(x \$39) | 312.                                |
| Multiple<br>Dependent<br>Claims: 0    |                     |                     | \$260<br>(\$130)   | 0.                                  |
| Assignment Recording Fee per property |                     |                     | \$40               | 0.                                  |
| Surcharge Under 37 C.F.R. 1.16(e)     |                     |                     | \$130<br>(\$65)    | 0.                                  |
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Respectfully submitted,

September 28, 2000  
Date

  
Irvin C. Harrington, III  
Reg. No. 40,740

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of

Attorney Docket No. 071815.0490

John HONG

Group Art Unit: Not Assigned

Serial No.: Not assigned

Examiner: Not assigned

Filed: Concurrently herewith

For: METHOD AND APPARATUS FOR MODIFYING ACOUSTIC WAVE CHARACTERISTICS

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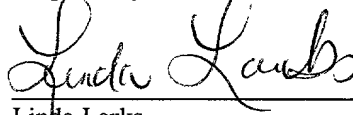
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1. Utility Application Transmittal Sheet
2. Specification, Claims and Abstract: 16 pages
3. Informal Drawings: 6 sheets
4. Declaration Under 37 C.F.R. § 1.63 (unsigned)
5. Check No. 13515 for \$1560.00 for filing fee
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September 28, 2000  
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Respectfully submitted,

  
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Linda Larks

# **METHOD AND APPARATUS FOR MODIFYING ACOUSTIC WAVE CHARACTERISTICS**

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## BACKGROUND

### Field of the Invention

The present invention relates to the field of acoustic wave processing. Particular  
5       embodiments of the invention relate to methods and devices that modify the characteristics of  
acoustic waves, such as variable bandwidth acoustic wave filters and acoustic wave delay  
devices.

### Related Art

The demand for products based on solid state technology in the consumer, industrial  
10       and military markets continues to grow at a rapid rate. For example, in the consumer  
telecommunications market, some forecasts estimate that mobile phone sales will reach an  
astounding 750 million to 1 billion units by 2003. Commensurate with this demand is a  
demand for the components inside these products, including signal processing components  
relying on acoustic wave phenomena. Acoustic wave devices, such as surface acoustic wave  
15       (SAW) and bulk acoustic wave (BAW) devices, are used frequently in products such as  
televisions, cell phones and pagers.

One application for acoustic wave devices is in electronic signal filtering. Electronic  
filters are ubiquitous and are available in a variety of technologies. For example, in cellular  
telephones, filters may be implemented using analog technology, as in charge coupled devices  
20       (CCDs), digital technology, as in finite impulse response (FIR) filters, or acoustic wave  
technology, all of which are well-known in the art. Analog and digital filters are versatile in  
the sense that the frequency response of these filters can be varied. These filters, however,  
suffer from an inability to directly address high frequency applications, such as, for example,  
applications in the vast majority of wireless communications markets, either because of  
25       fundamental component frequency limitations or an adverse power-speed relationship. This is  
troublesome for many designers, especially those designing in the wireless electronics area,  
where bandwidth and frequency of operation continue to increase and power is at a premium.  
In some applications, the power consumption of analog and digital filters is too great for these  
filters to be viable as design solutions. Filters based on acoustic wave technology, however,

which consume very little power in relation to analog and digital filters, offer a viable solution to this problem.

However, acoustic wave devices have not been without their problems. Historically, acoustic wave devices have been limited in flexibility. For example, SAW filters are typically used for fixed filter applications. Once fabricated, a SAW filter is fixed with respect to bandwidth and center frequency. If a different frequency response is desired, a new SAW filter must be substituted.

There have been attempts to address this problem. In U.S. Patent #3,446,974, issued to Seiwatz, a solid state acoustic signal translating device, such as a surface acoustic wave filter, is described in which a photoconductive film contacts the surface electrodes of the device transducer. An optical system illuminates selected portions of the photoconductive film to establish various connections between electrodes, thereby varying the frequency response of the device, which is dependent upon the particular electrodes activated. This approach to vary the frequency response of the device has several disadvantages: there is substantial loss due to the resistive drop across the electrodes; the shape of the filter changes dramatically as different electrodes are selected; and, electrode selection is not arbitrary due to the pre-defined electrode pattern.

A purported improvement on the Seiwatz device is described in U.S. Patent #3,621,482, issued to Adler. The Adler device is essentially a plurality of SAW filters selectively coupled together via a photoconductive material. Although the Adler device may improve upon the resistive loss problem of the Seiwatz device, the number of filter structures needed for the Adler device grows in proportion to the number of frequency selections to be made. This may make the Adler device too costly, too cumbersome or otherwise unusable in many instances.

Another approach is described in U.S. Patent #4,099,206, issued to Desbois et al. The Desbois device consists of a substrate of piezoelectric material upon which is deposited an interdigital network and electro-acoustic transducers. The interdigital network is covered by, but electrically isolated from, a photoconductive medium. Illumination of the photoconductive material affects the conductivity of the network, thereby influencing the surface acoustic wave

generated and received by the transducers. This device also suffers from resistive losses, and its tunability is limited, as in the Seiwatz device, by the pre-defined geometry of the network.

Thus, there is a need to provide a method and apparatus for varying the frequency characteristics of acoustic waves, without the resistive losses of previous devices and with tunability that does not rely on a pre-defined control structure.

#### SUMMARY

Embodiments of the present invention are directed to methods and apparatuses that address this need. In one embodiment, a method for modifying the characteristics of an acoustic wave comprises the steps of providing a medium for acoustic wave propagation, generating an acoustic wave, propagating the acoustic wave using the medium, and illuminating the medium during the propagation of the acoustic wave. The medium may be a piezoelectric substrate. A transducer may be formed on the piezoelectric substrate, and the transducer may generate the acoustic wave. Further, the medium may be illuminated using a laser diode or a light-emitting diode. The method may also comprise the step of varying the intensity of the light generated by the light-emitting diode or laser diode. The intensity of the light may be varied by a controller or a light modulator. The method may also comprise the step of reading a selected frequency component of the acoustic wave.

Another embodiment of the present invention is directed toward a method for modifying the characteristics of an acoustic wave comprising the steps of generating an acoustic wave in a medium and varying a velocity of the acoustic wave. This medium may also be a piezoelectric substrate. The velocity of the acoustic wave may be varied by illuminating the medium. Further, a transducer may be formed on the piezoelectric substrate and the acoustic wave may be generated by the transducer. In addition, the method of this embodiment may also comprise the step of reading a selected frequency component of the acoustic wave.

Another embodiment of the present invention is directed toward an apparatus for varying the characteristics of an acoustic wave comprising a medium for acoustic wave propagation, a transducer formed on the medium, and a light source illuminating the medium. The medium may be a piezoelectric substrate and the acoustic wave may be generated by the transducer. The light source may be a laser diode or a light-emitting diode and the intensity of

the light generated by either light source may be varied. To vary the intensity of the light, a controller or a light modulator may be used. In the apparatus, a selected frequency component of the acoustic wave may be read from the transducer.

Another embodiment of the present invention is directed toward a method for making an acoustic wave device comprising the steps of providing a medium for acoustic wave propagation, forming a transducer on the medium and providing a light source for illuminating the medium. The medium may be a piezoelectric substrate. The light source may be a laser diode or a light-emitting diode. The method may also comprise the step of providing means for varying an intensity of a light generated by the light-emitting diode. The means for varying the intensity of the light may comprise a controller or a light modulator.

Another embodiment of the present invention is directed toward an apparatus for varying the characteristics of an acoustic wave comprising a medium for acoustic wave propagation and a transducer formed on the medium, wherein a light source is used to illuminate the medium. The medium may be a piezoelectric substrate. The transducer may generate an acoustic wave. The light source may be a laser diode or a light-emitting diode. In this embodiment, an intensity of a light generated by the laser diode or light-emitting diode is varied, preferably by a controller or a light modulator. A selected frequency component of the acoustic wave is read from the transducer.

Another embodiment of the present invention is directed toward a method for modifying the characteristics of an acoustic wave comprising the steps of providing a medium for acoustic wave propagation, generating an acoustic wave, propagating the acoustic wave using the medium, and inducing a charge grating in the medium during the propagation of the acoustic wave. The medium may be a piezoelectric substrate and a transducer may be formed on the piezoelectric substrate.

Another embodiment of the present invention is directed toward a method for making an acoustic wave device comprising the steps of providing a medium for acoustic wave propagation, forming a transducer on the medium, and providing a light source for inducing a charge grating in the medium. The medium may be a piezoelectric substrate. The light source may be a laser diode or a light-emitting diode. The method may also comprise the step of providing means for varying an intensity of a light generated by the light-emitting diode,



wherein the means for varying the intensity of the light comprises a controller or a light modulator.

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### BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when viewed in light of the accompanying drawings where:

FIG. 1 is a perspective view of the prior art.

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FIG. 2 is a perspective view of a preferred embodiment of the invention.

FIG. 3 illustrates the mechanism by which the method and embodiments of the invention may be explained.

FIG. 4 is a perspective view of another preferred embodiment of the invention.

FIG. 5 is a side view of another preferred embodiment of the invention.

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FIG. 6 is a side view of another preferred embodiment of the invention.

### DETAILED DESCRIPTION

The present invention relies on the change in propagation velocity and the reflection of various components of acoustic waves across or through a medium due to an optically induced charge grating. Implementations of the present invention may be accomplished in a variety of ways; however, for purposes of illustration a typical SAW device will be described as a representative example.

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SAW devices are well-known in the art and will be described here only briefly. SAW devices take advantage of the properties of acoustic waves and typically utilize piezoelectric materials. In a SAW device, acoustic waves may propagate along the SAW surface (i.e., the substrate of the SAW device). If the SAW surface is a piezoelectric material, the surface acoustic energy is accompanied by a small amount of electromagnetic energy. This electromagnetic energy provides the mechanism by which the acoustic and electric fields may be coupled, thus converting a propagating surface acoustic wave into an electromagnetic signal and vice versa.

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A basic SAW device is shown in FIG. 1. Transducers 110, 112 can be fabricated from metal interdigital electrodes 114 and formed onto a piezoelectric substrate 120. In FIG. 1, the left-hand transducer 110 is connected to a source 130 having a source voltage 132 and a source resistance 134. Upon excitation by the electrical signal generated by the source 130, a portion  
5 of the electromagnetic energy at the left-hand transducer 110 is converted to acoustic energy and propagates as an acoustic wave upon the surface of the piezoelectric substrate 120 toward the right-hand transducer 112. As the acoustic wave becomes incident upon the right-hand transducer 112, the acoustic energy is converted back into electromagnetic energy and provided to the load 140. In the basic SAW device of FIG. 1, the wavelength of the  
10 propagating acoustic wave is proportional to the spacing of the metal interdigital electrodes 114. Thus, the frequency response of a filter using these devices can be modified by varying the spacing between each digit of the metal interdigital electrodes 114.

A preferred embodiment illustrating a method and apparatus of an embodiment of the present invention is shown in FIG. 2. The basic SAW device discussed above is modified by  
15 depositing only one transducer 210 having interleaved electrodes 212 onto a piezoelectric substrate 220. Leads 230 are brought out from the transducer electrodes 212 so as to form a single-port device. The transducer 210 may be excited by a signal source (not shown) employing excitation techniques that are common in the art. Typically, the transducer 210 would be excited by an electronic, oscillating waveform of a frequency desired by the user.  
20 Excitation of the transducer 210 gives rise to an acoustic wave propagating along the surface of the piezoelectric substrate 220. The regions of the piezoelectric substrate 220 adjacent to either side of the transducer 210 are then illuminated with a light source 240. Upon illumination, the velocity of the acoustic wave propagation along the surface of the piezoelectric substrate 220 will change, and a frequency component of the acoustic wave will  
25 be reflected, based on the characteristics, such as wavelength and intensity, of the light emitted from the light source 240. The wavelength, intensity and other characteristics of the light emitted from the light source 240 may be selected depending on the needs of the user. By varying these and other parameters of the illumination, the user can also vary the velocity and reflected component of the acoustic wave. Subsequent to illumination, a particular frequency

component of the acoustic wave, or the acoustic wave itself, both being functions of the illumination, is coupled to the transducer 210 and may be retrieved at the leads 230.

A mechanism by which the method and apparatus according to an embodiment of the present invention is accomplished may be explained with reference to FIG. 3. Acoustic waves 310 can propagate on or through the surface of a medium 320, which may have piezoelectric properties, giving rise to dipole moments, or charge imbalances, and a resultant electric field within the medium 320. Conversely, an electric field induced upon or within the medium 320 can give rise to mechanical stress within the medium 320 and resultant acoustic waves. The coupling  $K^2$  between the acoustic waves and the electric field may be defined as

$$K^2 = e^2/\epsilon c = -2\Delta v/v,$$

where  $e$  is the piezoelectric coefficient,  $\epsilon$  is the dielectric permittivity,  $c$  is the elastic constant,  $v$  is the velocity of the propagating acoustic wave in an unperturbed medium, and  $\Delta v$  is the change in velocity observed when the surface electric potential is shorted. This factor, which is for a simple isotropic case, quantifies the fractional change in the velocity of the acoustic wave propagation due to the electromechanical coupling.

If the medium 320 is illuminated, free charges appear within the bulk of the medium 320, resulting in an optically induced charge grating 330. The charge grating 330 acts as a variable interdigital or interleaved network and serves to cancel or relax the electric field at various points within the medium 320 in the direction of the propagating acoustic waves 310. These varying fields change the velocity of the acoustic waves 310 incident upon these fields, giving rise to selective reflection of particular frequency components of the acoustic waves 310. This phenomena is commonly referred to as Bragg reflection. The selected frequency can then be coupled out of the medium 320 via transducer (not shown). Various frequencies may be selected by varying the charge grating 330, which is easily accomplished by varying the illumination on the medium 320. The illumination on the medium 320 may be varied using a variety of techniques, for example, using an optical intensity grating (i.e., the intensity distribution varies spatially as a sinusoid with a characteristic grating spacing).

Referring again to FIG. 2, the piezoelectric substrate 220 may be fabricated from a variety of materials. If ferroelectric crystals are desired, lithium niobate ( $\text{LiNbO}_3$ ) and lithium tantalate ( $\text{LiTaO}_3$ ) may be used. Semiconductors such as gallium arsenide (GaAs) or indium

phosphide may also be used. Bismuth germanium oxide ( $\text{Bi}_{12}\text{GeO}_{20}$ ) and related semi-insulators are also candidates. Other embodiments may employ other suitable materials, such materials typically having relatively large electromechanical effects and photoconductivity.

The transducer 210 can be made from any suitable conductive metal or other electrically conductive material. Its exact geometry and spacing depends on the needs of the user. The transducer 210 may be formed on the piezoelectric substrate 220 using any of the methods that are common within the industry, including, but not limited to, deposition processes, etching processes, photolithography, or the like. In some embodiments, the transducer 210 may be formed on the piezoelectric substrate 220 by simple mechanical attachment.

The light source 240 may also be implemented in a variety of ways. Laser diodes may be used if desired. In the event a laser diode does not provide the desired wavelength, light-emitting diodes (LEDs) may be used. LEDs are common in the art and emit a variety of wavelengths, including blue light. Other suitable types of light sources may be employed in other embodiments.

Another preferred embodiment of a method and apparatus of the present invention is shown in FIG. 4. A basic SAW device 410 having a first transducer 430 and a second transducer 460 is illuminated with a light source 420 having a particular wavelength or wavelengths and a particular intensity. The first transducer 430 is excited by a signal source 440, such as an electronic oscillating waveform, giving rise to an acoustic wave propagating along the surface of the piezoelectric substrate 450. The selected frequency, being a function of the characteristics of the light source 420, is coupled to the second transducer 460 and used at the load 470. Note that in this embodiment, as well as in other embodiments of the method and apparatus of the present invention, there is no need to employ any photoconductive layers to modify the characteristics of the acoustic wave.

The versatility of embodiments of the present invention are readily apparent. By appropriately tuning or varying the characteristics of the light source and/or the illumination of the medium, a desired frequency may be reflected in the medium, or a desired delay in the propagation velocity of the acoustic wave may be achieved, and retrieved via the transducer, all without the use of loss-inducing photoconductive layers. The charge grating resulting from

the illumination of the medium functions as a variable interdigital or interleaved network, and may be described as "light fingers." By varying the illumination of the medium, the charge grating is also varied, resulting in a change in the frequency response of the device. Thus, a variable filter or resonator may be achieved.

5 Further, appropriately tuning or varying the light source and/or the illumination of the medium will result in a desired velocity of the propagating acoustic wave. Thus, variable delay lines may also be easily achieved. Embodiments of the present invention makes it easy to vary light finger spacing, the number of light fingers in a given region of the medium, the ratio of light-to-dark regions in the medium, and other characteristics, all with attendant  
10 variations in the frequency response of the device. Although the present invention may be used for any range of frequencies, it is particularly useful in the intermediate frequency range and finds application at frequencies ranging from 10 MHz to 1 GHz and beyond. However, devices utilizing further embodiments of the present invention may be applied to frequencies across the spectrum.

15 Because embodiments of the present invention do not require that electrical signals pass through photoconductive regions, the resistive losses and attendant degradations in signal levels and signal quality associated with the prior art may be eliminated. Further, because embodiments of the present invention do not rely on prefabricated control structures, device tunability may be easy and inexpensive with respect to those embodiments. Devices according  
20 to embodiments of the present invention may be fabricated easily using current solid state technology techniques and may be made as small as current techniques will allow.

Another preferred embodiment demonstrating broad versatility is shown in FIG. 5. Transducers 510 are formed upon a piezoelectric substrate 520 using common techniques. A first light source 530 is controlled by a first controller 532 while a second light source 540 is  
25 controlled by a second controller 542. The first light source 530 and the second light source 540 are positioned such that they directly illuminate the transducers 510. The first controller 532 and the second controller 542 can be any suitable type of controller, typically an electronic controller. In one example embodiment, the controllers may be designed with circuitry containing a microprocessor or microcontroller. By operating the first controller 532 and the  
30 second controller 542 in such a way that the intensity of the first light source 530 is different

from that of the second light source 540, the resulting charge grating at each portion of the piezoelectric substrate 520 will be different, resulting in a particular frequency response for the device. By varying the intensity, the wavelength or other characteristics of each light source 530, 540, a variable acoustic wave device may be achieved. Such devices may include, among  
5 other components, variable filters, variable resonators, and variable delay lines.

A method and apparatus according to another preferred embodiment of the present invention is shown in FIG. 6. This embodiment is similar to the embodiment described in FIG. 2 with the addition, however, of a light modulator 650. A transducer 610 is formed upon a piezoelectric substrate 620, again preferably using common techniques. A first light source  
10 630 is controlled by a first controller 632 while a second light source 640 is controlled by a second controller 642. The first light source 630 and second light source 640 are positioned such that they illuminate the region of the piezoelectric substrate 620 adjacent to either side of the transducer 610. The first controller 632 and the second controller 642 are operated in such a way that the intensity, the wavelength or other characteristics of the first light source 630 and  
15 the second light source 640 are about the same. Tunability of the device is achieved by varying the light modulator 650 such that the intensity, the wavelength or other characteristics of the illumination on the region of the piezoelectric substrate 620 under the first light source 630 is different than the intensity, the wavelength or other characteristics of the illumination on the region of the piezoelectric substrate 620 under the second light source 640.

20 The light modulator may be fabricated in a variety of ways or could be any number of devices. For example, it could be a liquid crystal display (LCD) panel, any type of optical filter, such filters being widely available on the market, any device capable of modulating or varying the intensity, the wavelength, or other characteristics of a light source, or any device that is suitable for grating pattern control.

25 While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that the invention is not limited to the particular embodiments shown and described and that changes and modifications may be made without departing from the spirit and scope of the appended claims.

# CLAIMS

What is claimed is:

1. A method for modifying the characteristics of an acoustic wave, comprising the steps of:  
  
providing a medium for acoustic wave propagation;  
generating an acoustic wave;  
propagating the acoustic wave using the medium; and  
illuminating the medium during the propagation of the acoustic wave.
2. The method of Claim 1, wherein the medium is a piezoelectric substrate.
3. The method of Claim 2, wherein a transducer is formed on the piezoelectric substrate.
4. The method of Claim 3, wherein the acoustic wave is generated by the transducer.
5. The method of Claim 1, wherein the medium is illuminated using a laser diode.
6. The method of Claim 1, wherein the medium is illuminated using a light-emitting diode.
7. The method of Claim 6, further comprising the step of varying an intensity of a light generated by the light-emitting diode.
8. The method of Claim 7, wherein the intensity of the light is varied by a controller.
9. The method of Claim 7, wherein the intensity of the light is varied by a light modulator.
10. The method of Claim 1, further comprising the step of reading a selected frequency component of the acoustic wave.
11. A method for modifying the characteristics of an acoustic wave, comprising the steps of:  
  
generating an acoustic wave in a medium; and  
varying a velocity of the acoustic wave.
12. The method of Claim 11, wherein the medium is a piezoelectric substrate.
13. The method of Claim 11, wherein the velocity of the acoustic wave is varied by illuminating the medium.

14. The method of Claim 12, wherein a transducer is formed on the piezoelectric substrate.
15. The method of Claim 14, wherein the acoustic wave is generated by the transducer.
16. The method of Claim 11, further comprising the step of reading a selected frequency component of the acoustic wave.
17. An apparatus for varying the characteristics of an acoustic wave, comprising:
  - a medium for acoustic wave propagation;
  - a transducer formed on the medium; and
  - a light source illuminating the medium.
18. The apparatus of Claim 17, wherein the medium is a piezoelectric substrate.
19. The apparatus of Claim 17, wherein the transducer generates an acoustic wave.
20. The apparatus of Claim 17, wherein the light source is a laser diode.
21. The apparatus of Claim 17 wherein the light source is a light-emitting diode.
22. The apparatus of Claim 21, wherein an intensity of a light generated by the light-emitting diode is varied.
23. The apparatus of Claim 22, wherein the intensity of the light is varied by a controller.
24. The apparatus of Claim 17, wherein a selected frequency component of the acoustic wave is read from the transducer.
25. The apparatus of Claim 22, wherein the intensity of the light is varied by a light modulator.
26. A method for making an acoustic wave device, comprising the steps of:
  - providing a medium for acoustic wave propagation;
  - forming a transducer on the medium; and
  - providing a light source for illuminating the medium.
27. The method of Claim 26, wherein the medium is a piezoelectric substrate.
28. The method of Claim 26, wherein the light source is a laser diode.
29. The method of Claim 26, wherein the light source is a light-emitting diode.
30. The method of Claim 26, further comprising the step of providing means for varying an intensity of a light generated by the light-emitting diode.
31. The method of Claim 30, wherein the means for varying the intensity of the light comprises a controller.



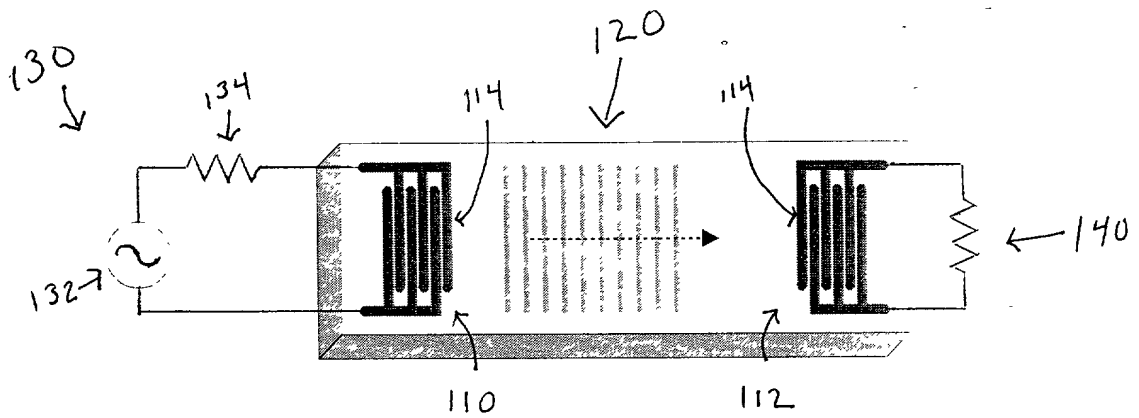
32. The method of Claim 30, wherein the means for varying the intensity of the light comprises a light modulator.
33. An apparatus for varying the characteristics of an acoustic wave, comprising:
  - a medium for acoustic wave propagation; and
  - a transducer formed on the medium,wherein a light source is used to illuminate the medium.
34. The apparatus of Claim 33, wherein the medium is a piezoelectric substrate.
35. The apparatus of Claim 33, wherein the transducer generates an acoustic wave.
36. The apparatus of Claim 33, wherein the light source is a laser diode.
37. The apparatus of Claim 33 wherein the light source is a light-emitting diode.
38. The apparatus of Claim 37, wherein an intensity of a light generated by the light-emitting diode is varied.
39. The apparatus of Claim 38, wherein the intensity of the light is varied by a controller.
40. The apparatus of Claim 33, wherein a selected frequency component of the acoustic wave is read from the transducer.
41. The apparatus of Claim 38, wherein the intensity of the light is varied by a light modulator.
42. A method for modifying the characteristics of an acoustic wave, comprising the steps of:
  - providing a medium for acoustic wave propagation;
  - generating an acoustic wave;
  - propagating the acoustic wave using the medium; and
  - inducing a charge grating in the medium during the propagation of the acoustic wave.
43. The method of Claim 42, wherein the medium is a piezoelectric substrate.
44. The method of Claim 43, wherein a transducer is formed on the piezoelectric substrate.
45. A method for making an acoustic wave device, comprising the steps of:
  - providing a medium for acoustic wave propagation;
  - forming a transducer on the medium; and
  - providing a light source for inducing a charge grating in the medium.

46. The method of Claim 45, wherein the medium is a piezoelectric substrate.
47. The method of Claim 45, wherein the light source is a laser diode.
48. The method of Claim 45, wherein the light source is a light-emitting diode.
49. The method of Claim 45, further comprising the step of providing means for varying an intensity of a light generated by the light-emitting diode.
50. The method of Claim 49, wherein the means for varying the intensity of the light comprises a controller.
51. The method of Claim 49, wherein the means for varying the intensity of the light comprises a light modulator.

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Prior Art

FIG. 1

F I G. 2

Reduced Electric Field from Photoconductive Shielding

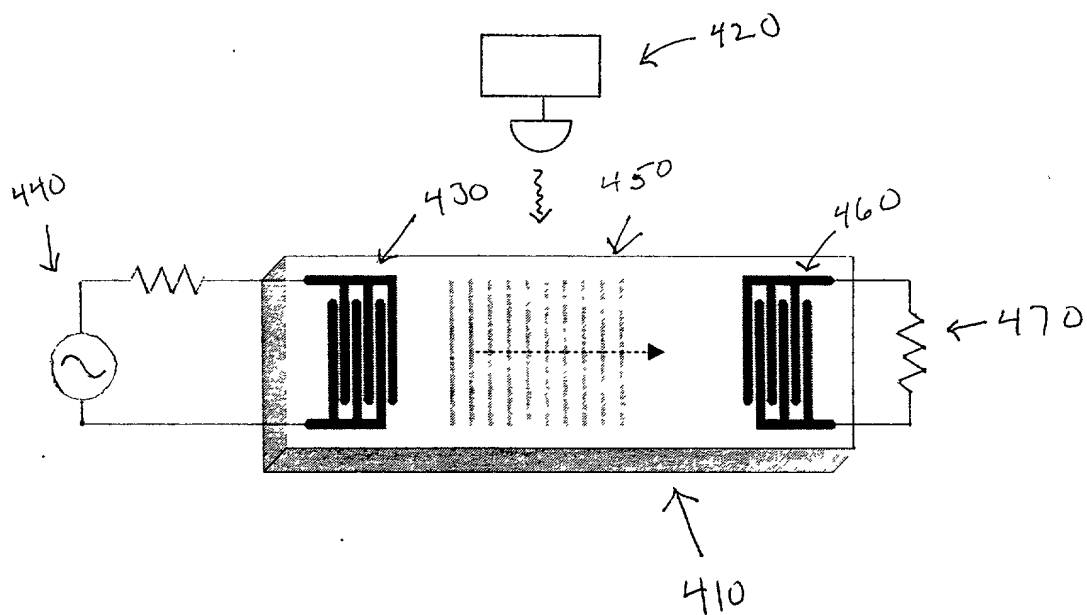
330

310

320

F16.3

FIG. 4

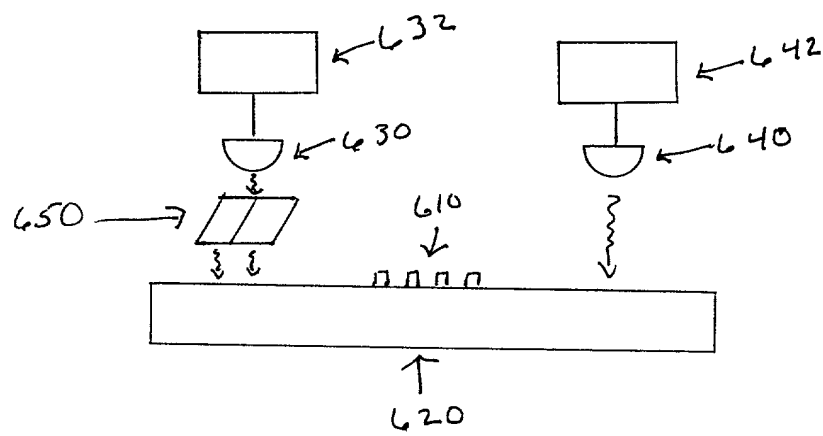


The diagram shows a mechanical system. At the top, there are two rectangular masses. The left mass is connected to a horizontal bar below it by a vertical spring. The right mass is also connected to the same horizontal bar by a vertical spring. The horizontal bar is supported by a central upward arrow. Various labels with arrows point to different parts of the system: '532' points to the left mass, '530' points to the spring between the left mass and the bar, '510' points to the left end of the bar, '542' points to the right mass, '540' points to the spring between the right mass and the bar, '510' points to the right end of the bar, and '520' points to the central upward support arrow.

FI 6.5



● ●  
● ●  
● ●



F I C. 6

**United States Patent Application**  
**DECLARATION UNDER 37 C.F.R. § 1.63**

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **METHOD AND APPARATUS FOR MODIFYING ACOUSTIC WAVE CHARACTERISTICS**

The specification of which

- a. ☒ is attached hereto.  
 b. ☐ was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_, which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (attached hereto).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

- a. ☒ no such applications have been filed.  
 b. ☐ such applications have been filed as follows:

| FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119         |                    |                                      |                                     |
|--|--------------------|--------------------------------------|-------------------------------------|
| COUNTRY  | APPLICATION NUMBER | DATE OF FILING<br>(day, month, year) | DATE OF ISSUE<br>(day, month, year) |
|  |                    |                                      |                                     |
| ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S) |                    |                                      |                                     |
| COUNTRY  | APPLICATION NUMBER | DATE OF FILING<br>(day, month, year) | DATE OF ISSUE<br>(day, month, year) |
|  |                    |                                      |                                     |

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

| U.S. PROVISIONAL APPLICATION NUMBER | DATE OF FILING (Day, Month, Year) |
|-------------------------------------|-----------------------------------|
|                                     |                                   |

Please direct all correspondence in this case to Ted R. Rittmaster, Esq. at the address indicated below:

Ted R. Rittmaster  
Foley & Lardner  
2029 Century Park East – Suite 3500  
Los Angeles, CA 90067-3021

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

|                                   |                            |                                    |                            |                                     |                                 |
|-----------------------------------|----------------------------|------------------------------------|----------------------------|-------------------------------------|---------------------------------|
| 201                               | 2                          | <b>Full Name Of Inventor</b>       | <b>Family Name</b><br>HONG | <b>First Given Name</b><br>John     | <b>Second Given Name</b><br>NMI |
|                                   | 0                          | <b>Residence &amp; Citizenship</b> | <b>City</b>                | <b>State or Foreign Country</b>     | <b>Country of Citizenship</b>   |
|                                   | <b>Post Office Address</b> | <b>Post Office Address</b>         | <b>City</b>                | <b>State &amp; Zip Code/Country</b> |                                 |
| <b>Signature of Inventor 201:</b> |                            |                                    |                            |                                     | <b>Date:</b>                    |
| 202                               | 2                          | <b>Full Name Of Inventor</b>       | <b>Family Name</b>         | <b>First Given Name</b>             | <b>Second Given Name</b>        |
|                                   | 0                          | <b>Residence &amp; Citizenship</b> | <b>City</b>                | <b>State or Foreign Country</b>     | <b>Country of Citizenship</b>   |
|                                   | <b>Post Office Address</b> | <b>Post Office Address</b>         | <b>City</b>                | <b>State &amp; Zip Code/Country</b> |                                 |
| <b>Signature of Inventor 202:</b> |                            |                                    |                            |                                     | <b>Date:</b>                    |
| 203                               | 2                          | <b>Full Name Of Inventor</b>       | <b>Family Name</b>         | <b>First Given Name</b>             | <b>Second Given Name</b>        |
|                                   | 0                          | <b>Residence &amp; Citizenship</b> | <b>City</b>                | <b>State or Foreign Country</b>     | <b>Country of Citizenship</b>   |
|                                   | <b>Post Office Address</b> | <b>Post Office Address</b>         | <b>City</b>                | <b>State &amp; Zip Code/Country</b> |                                 |
| <b>Signature of Inventor 203:</b> |                            |                                    |                            |                                     | <b>Date:</b>                    |
| 204                               | 2                          | <b>Full Name Of Inventor</b>       | <b>Family Name</b>         | <b>First Given Name</b>             | <b>Second Given Name</b>        |
|                                   | 0                          | <b>Residence &amp; Citizenship</b> | <b>City</b>                | <b>State or Foreign Country</b>     | <b>Country of Citizenship</b>   |
|                                   | <b>Post Office Address</b> | <b>Post Office Address</b>         | <b>City</b>                | <b>State &amp; Zip Code/Country</b> |                                 |
| <b>Signature of Inventor 204:</b> |                            |                                    |                            |                                     | <b>Date:</b>                    |

**§ 1.56 Duty to disclose information material to patentability.**

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim;  
or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

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